REMARKS

Upon entry of this Amendment, claims 1-47 will be pending in this application. Claims 9-39 have been withdrawn from consideration. Claims 40-47 have been added.

Claim Rejections – 35 U.S.C. § 103

Claims 1-5, 7 and 8 have been rejected under 35 U.S.C. § 103 (a) as being unpatentable over Jacobs *et al.* (US Pat. No. 4,027,320) in view of Campbell, The Science and Engineering of Microelectronic Fabrication, pages 29-31. Applicants respectfully traverse this rejection for at least the following reasons.

With regard to claim 1, the Office Action contends that Jacobs *et al.* teaches a semiconductor device characterized by a silicon substrate (1); a silicon oxide film (4) containing krypton (col. 2, lines 58-61). The Office Action concedes that Jacobs *et al.* fails to teach a silicon substrate comprising (111) oriented crystal. The Office Action contends, however, that Campbell teaches a silicon wafer formed from a boule and having a (111) orientation (Figure 2-23) and it would have been obvious to one of ordinary skill in the art to select a commercially available wafer with a (111) orientation since it is commonly used in the art for p-type and n-type wafers.

Claim 1 has been amended to further recite "said Si oxide film being substantially free from crystal defects." Support for the claim language may be found throughout the initial disclosure. For example, the Examiner attention is directed to Figure 5 and related description in pages 16 and 17 of the specification.

Applicants submit that this amendment to claim 1 obviates the rejection in view of the above cited references.

Applicants submit that by forming the Si oxide film containing Kr in an oxidation process in the presence of Kr, the Si oxide film is made substantially free from crystal defects, as explained for example in page 16 and 17 of the specification. By using the Si oxide thus formed, as a gate insulation film for example, the fabrication of high-performance semiconductor device becomes possible (see, for example, page 6, lines 26-32).

In response to Examiner's arguments, Applicants reiterate the arguments in the November 14, 2002 response to the Office Action dated August 14, 2002. As conceded by the Examiner, Jacobs *et al.* fails to teach a silicon crystal having a (111) surface. Moreover, Jacobs *et al.* is silent about providing an insulation film formed on the (111) surface of the

silicon crystal and at least part of the insulation film comprises a Si oxide film containing Kr, the Si oxide film being substantially free from crystal defects. In fact, contrary to the subject matter recited in claim 1, Jacobs *et al.* intentionally induces defects in an already existing oxide film by introducing Kr and Xe atoms into the silicon oxide film by ion implantation.

With regard to Campbell, this reference merely shows various orientations of a silicon crystal. Campbell does not disclose, teach or suggest an insulation film can be formed on a (111) surface of the Si crystal.

Therefore, Applicants respectfully submit that none of the references cited by the Examiner disclose, teach or suggest, alone or in combination, the subject matter recited in claim 1.

Claim 3 has been rewritten in independent form. Claim 3 recites, *inter-alia*, "wherein at least a part of said insulation film comprises a Si oxide film containing Kr, and a Kr concentration level decreases in said Si oxide film from a surface of said Si oxide film to an interface between said Si oxide film and said Si crystal."

In contrast, Jacobs *et al.* the Kr ions are injected perpendicular to the substrate through the already formed silicon oxide film 4 (see, col. 2, lines 58-61). Thus, the peak position of the Kr comes inevitably below the surface level of the oxide film 4. Applicants submit that it is not easy to control an ion implantation process such that the peak concentration of the injected ions coincide with the top surface of the oxide film. Applicants submit that Jacobs *et al.* achieves the desired memory function by trapping electrons or holes in a trap formed by ion implantation of Kr ions. With the trapping of electrons (or holes) the threshold voltage of the transistor undergoes shifting in a positive (or negative) direction and the shifting of the threshold voltage is detected at the time of reading the information. Applicants submit that even if the trap density is maximum at the surface of the oxide film 4, which Applicants do not concede, the electrons (or holes) trapped would immediately escape to the gate electrode 5 and no desired memory operation would be achieved. For this reason, in order to achieve a memory operation of the device, Jacobs *et al.* Kr ion implantation is implemented such that the Kr ion concentration level increases from the surface of the oxide film 4 towards the interior of the oxide film.

With regard to Campbell, this reference merely shows various orientations of a silicon crystal. Campbell does not disclose, teach or suggest an insulation film can be formed on a (111) surface of the Si crystal.

Therefore, Applicants respectfully submit that none of the references cited by the Examiner disclose, teach or suggest, alone or in combination, the subject matter recited in claim 3.

Therefore, Applicants respectfully submit that claims 1 and 3, and claims 2, 4, 5, 7 and 8 which are dependent from claim 1, are patentable and respectfully request that the rejection of claims 1-5, 7 and 8 under § 103(a) be withdrawn.

Claim 6 has been rejected under 35 U.S.C. § 103 (a) as being unpatentable over Jacobs *et al.* (US Pat. No. 4,027,320) in view of Campbell, The Science and Engineering of Microelectronic Fabrication, pages 29-31 as applied to claim 1, and further in view of Campbell, pages 394-396.

Applicants respectfully submit that claim 6 is patentable for at least the reasons presented above for claim 1. Therefore, Applicants respectfully request that the rejection of claim 6 under § 103(a) be withdrawn.

Claims 40-47 have been newly added. Claims 41-47 correspond to claims 2-8 but depending from claim 40. Claim 40 recites, *inter-alia*, "wherein at least a part of said insulation film comprises a Si oxide film containing Kr, wherein said Kr reduces current leakage and improves breakdown characteristics of said insulation film when formed on said (111) surface of said Si crystal." Support for the claim language may be found throughout the specification, for example, at page 18 of the specification.

Jacobs *et al.* fails to teach a silicon crystal having a (111) surface. Moreover, Jacobs *et al.* is silent about providing an insulation film formed on the (111) surface of the silicon crystal and at least part of the insulation film comprises a Si oxide film containing Kr, wherein the Kr reduces current leakage and improves breakdown characteristics of the insulation film. In Jacobs *et al.*, Kr is merely introduced in the silicon oxide for the purpose of forming crystal defects or traps, not to reduce current leakage and improve breakdown characteristics of the silicon oxide.

With regard to Campbell, as stated previously, this reference merely shows various orientations of a silicon crystal. Campbell does not disclose, teach or suggest an insulation film can be formed on a (111) surface of the Si crystal.

Therefore, Applicants respectfully submit that claim 40 and claims 41-47 which are dependent therefrom are patentable.

CONCLUSION

In view of the foregoing, the claims are now in form for allowance, and such action is hereby solicited. If any point remains in issue which the Examiner feels may be best resolved through a personal or telephone interview, he is kindly requested to contact the undersigned at the telephone number listed below.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached Appendix is captioned **"Version with markings to show changes made"**.

All objections and rejections having been addressed, it is respectfully submitted that the present application is in a condition for allowance and a Notice to that effect is earnestly solicited.

Respectfully submitted,
Pillsbury Winthrop LLP

By: _____

Dale S. Lazar
Reg. No.: 28,872
Tel. No.: (703) 905-2126
Fax No.: (703) 905-2500

DSL/KXG
1600 Tysons Boulevard
McLean, VA 22102
(703) 905-2000
Enclosure: Appendix

APPENDIX

version with markings to show changes made

IN THE CLAIMS

Claim 1 has been amended as follows:

1. (Twice Amended) A semiconductor device comprising:
a Si crystal having a (111) surface; and
an insulation film formed on said (111) surface of said Si crystal,
wherein at least a part of said insulation film comprises a Si oxide film containing Kr, said Si oxide film being substantially free from crystal defects.

3. (Amended) A semiconductor device [as claimed in claim 1,] comprising:
a Si crystal having a (111) surface; and
an insulation film formed on said (111) surface of said Si crystal,
wherein at least a part of said insulation film comprises a Si oxide film containing Kr, and [wherein] a Kr concentration level decreases in said Si oxide film from a surface of said Si oxide film to an interface between said Si oxide film and said Si crystal.

Claims 40-47 have been added.

End of Appendix